

CHP – The Concept (Animal and Wood Waste)

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Presentation Outline

- Overview of DG / CHP
- Biogas CHP Applications
- Summary

Distributed Generation

DG is ...

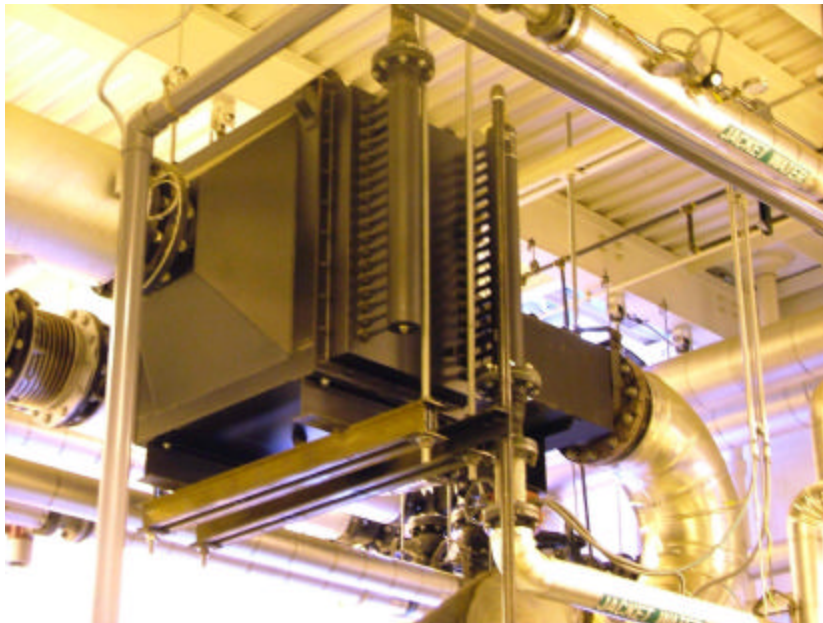
- An Electric Generator
- Located At a Substation or Near a Building / Facility
- Generates at least a portion of the Electric Load

DG Technologies

- Solar Photovoltaic
- Wind Turbines
- Engine Generator Sets
- Turbine Generator Sets
 - Combustion Turbines
 - Micro-Turbines
 - Steam Turbines
- Fuel Cells

Combined Heat & Power (CHP)

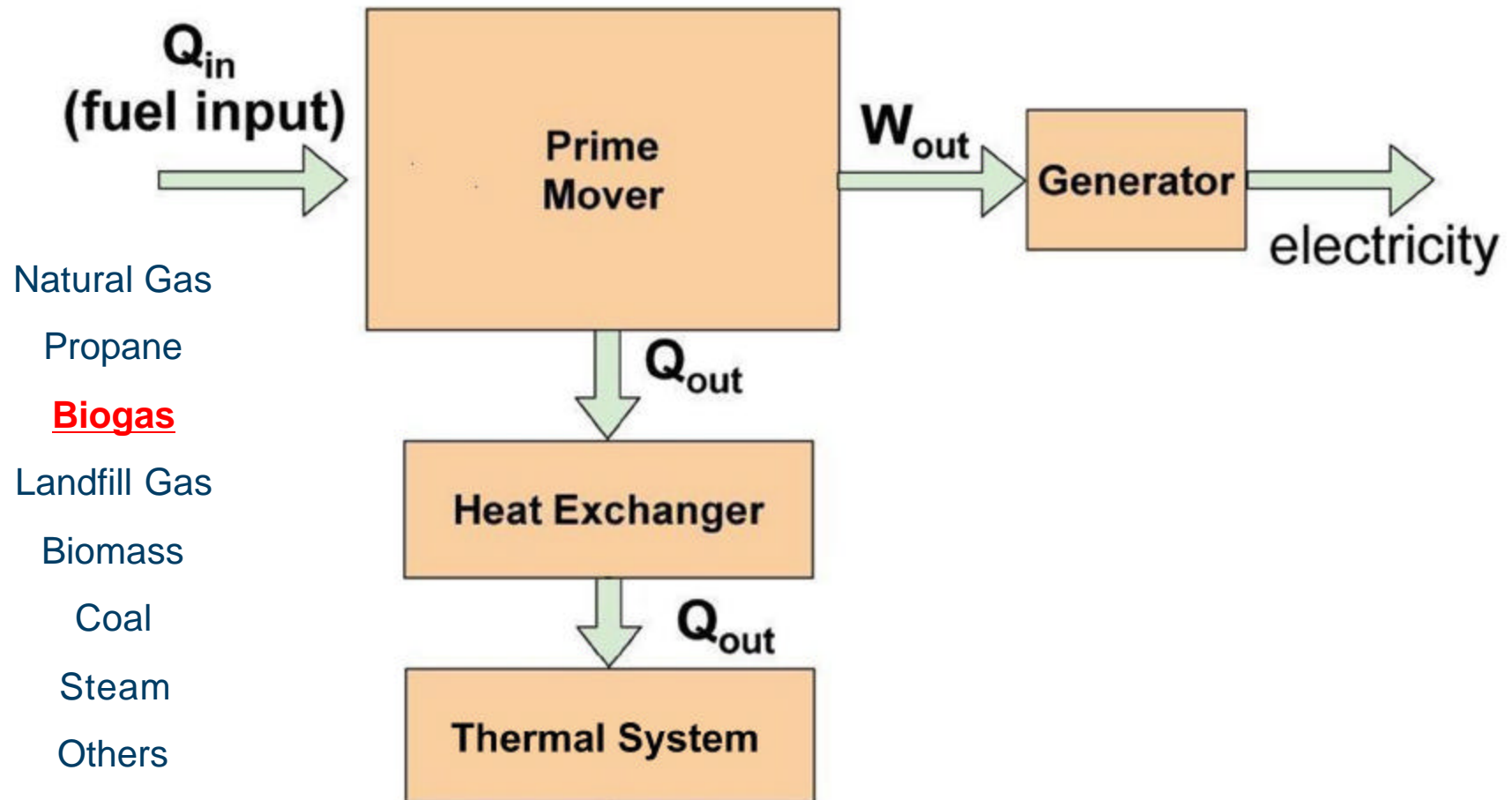
A Form of Distributed Generation



CHP is ...

- An Integrated System
- Located At or Near a Building/Facility
- Provides at Least a Portion of the Electrical Load and
- Recycles the Thermal Energy for
 - Space Heating / Cooling
 - Process Heating / Cooling
 - Dehumidification

Combined Heat and Power



Normal CHP Configuration

- CHP Systems are Normally Installed in Parallel with the Electric Grid (CHP does not replace the grid)
- Both the CHP and Grid Supply Electricity to the Customer
- Recycled Heat From the Prime Mover Used for:
 - Space Heating (Steam or Hot Water Loop)
 - Space Cooling (Absorption Chiller)
 - Process Heating and/or Cooling
 - Dehumidification (Desiccant Regeneration)

Generators and Inverters

Two Types of Generators

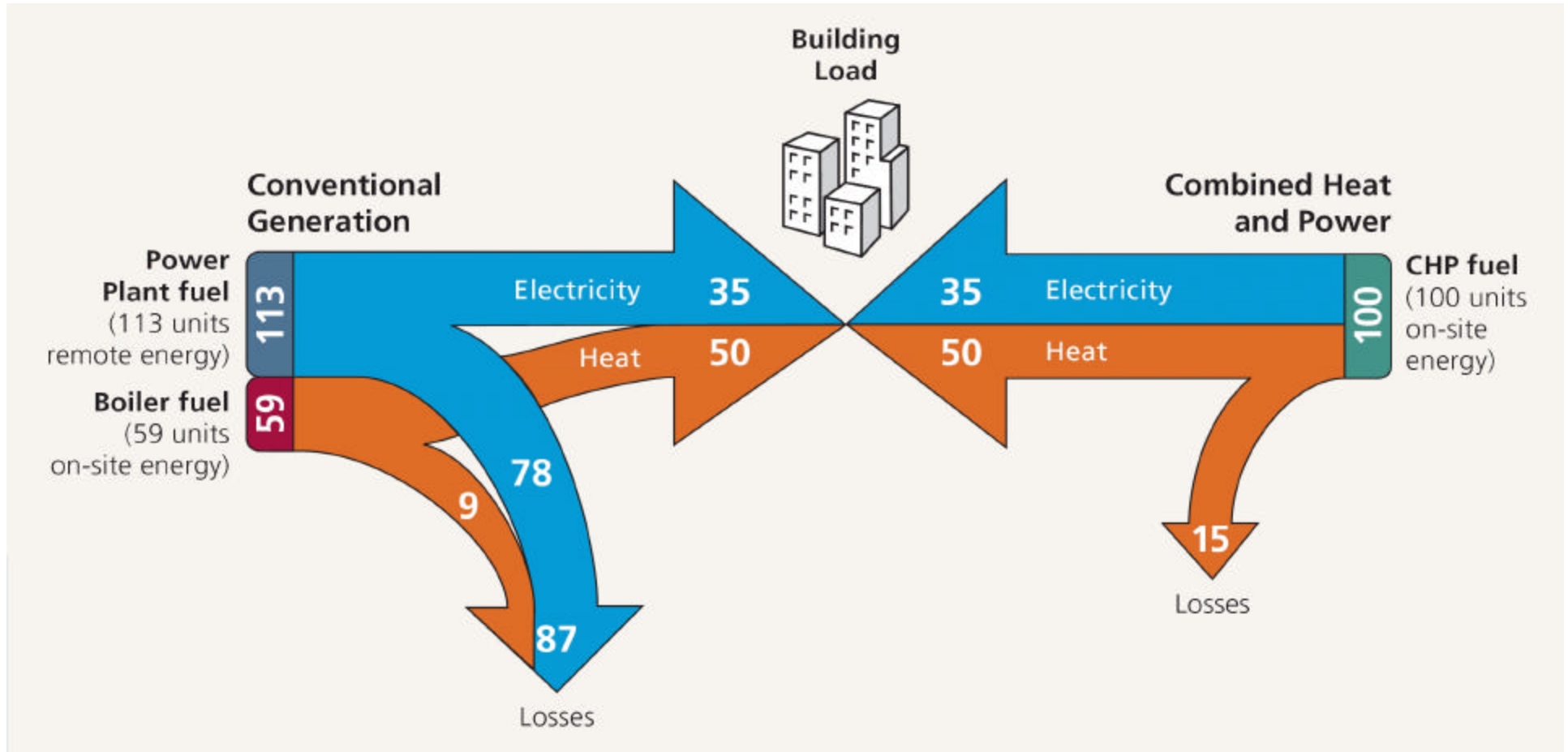
Induction

- Requires External Power Source to Operate (Grid)
- When Grid Goes Down, CHP System Goes Down
- Less Complicated & Less Costly to Interconnect
- Preferred by Utilities

Synchronous

- Self Excited (Does Not Need Grid to Operate)
- CHP System can Continue to Operate thru Grid Outages
- More Complicated & Costly to Interconnect (Safety)
- Preferred by CHP Customers

Conventional Generation vs. CHP



Candidate Applications for CHP

- Hospitals
- Colleges / Universities
- High Schools
- Residential Confinement
- High Rise Hotels
- Fitness Centers
- Food Processing Waste
- Farm Livestock Waste
- Waste Water Treatment
- Landfill Sites
- Industrial Waste
- Chemicals Manufacturing
- Pulp & Paper
- Ethanol / Biodiesel Plants

What are the Customer Benefits of CHP?



CHP does not make sense in all applications, but where it does make technical and economic sense, it will provide

- Lower Energy Costs
- Reduced Energy Consumption
- Increased Electric Reliability
- Standby Power
- Improved Environmental Quality

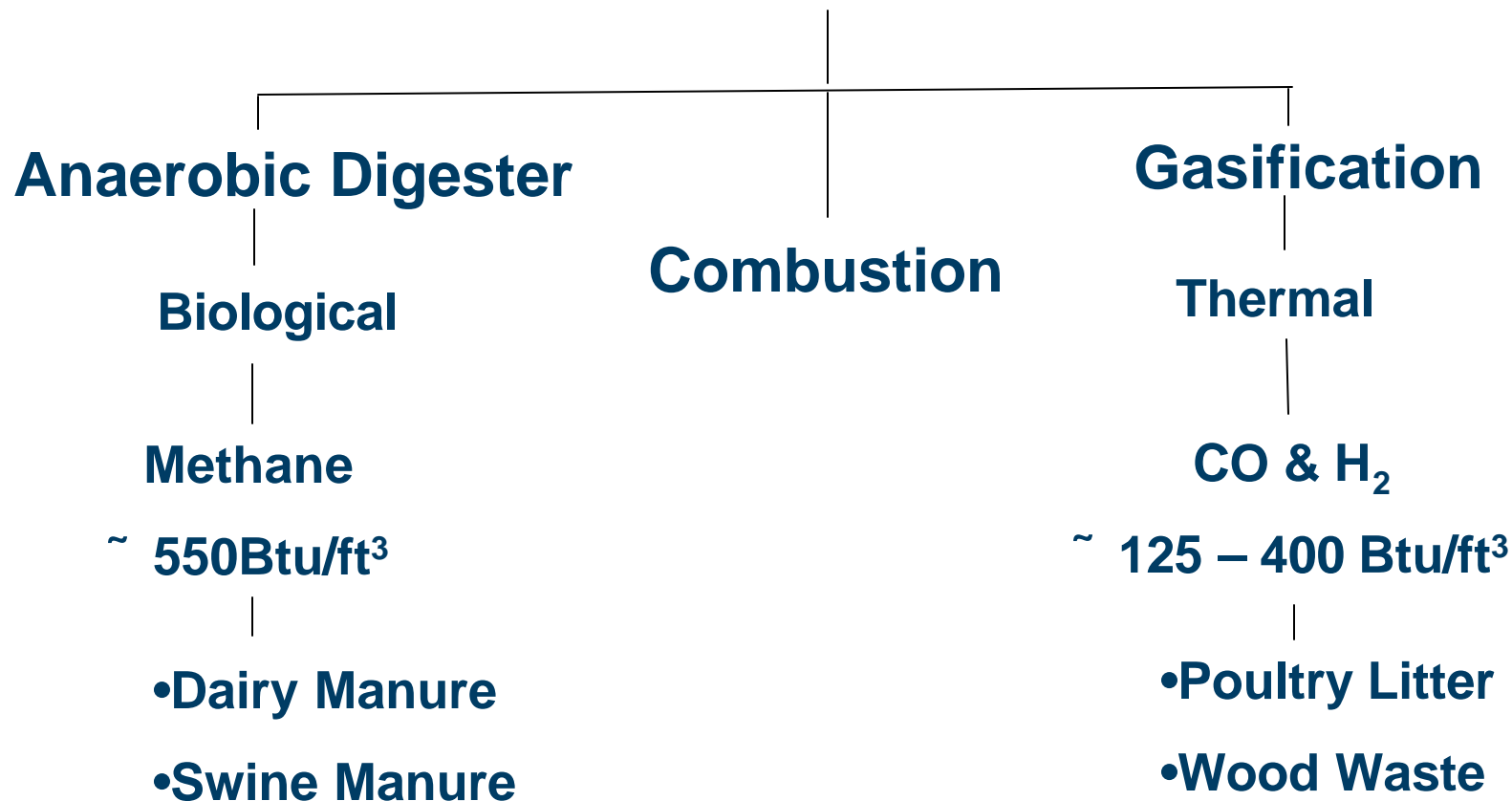
Installed CHP

- 82,400 MW at approx. 3000 sites (Nationally)
- Represents approx. 9% of total US generating capacity
- Saves an estimated 3 Quads of fuel per year
- Eliminates over 400 million tons of CO₂ emissions annually

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- 1,870 MW at approx. 32 sites (Indiana)

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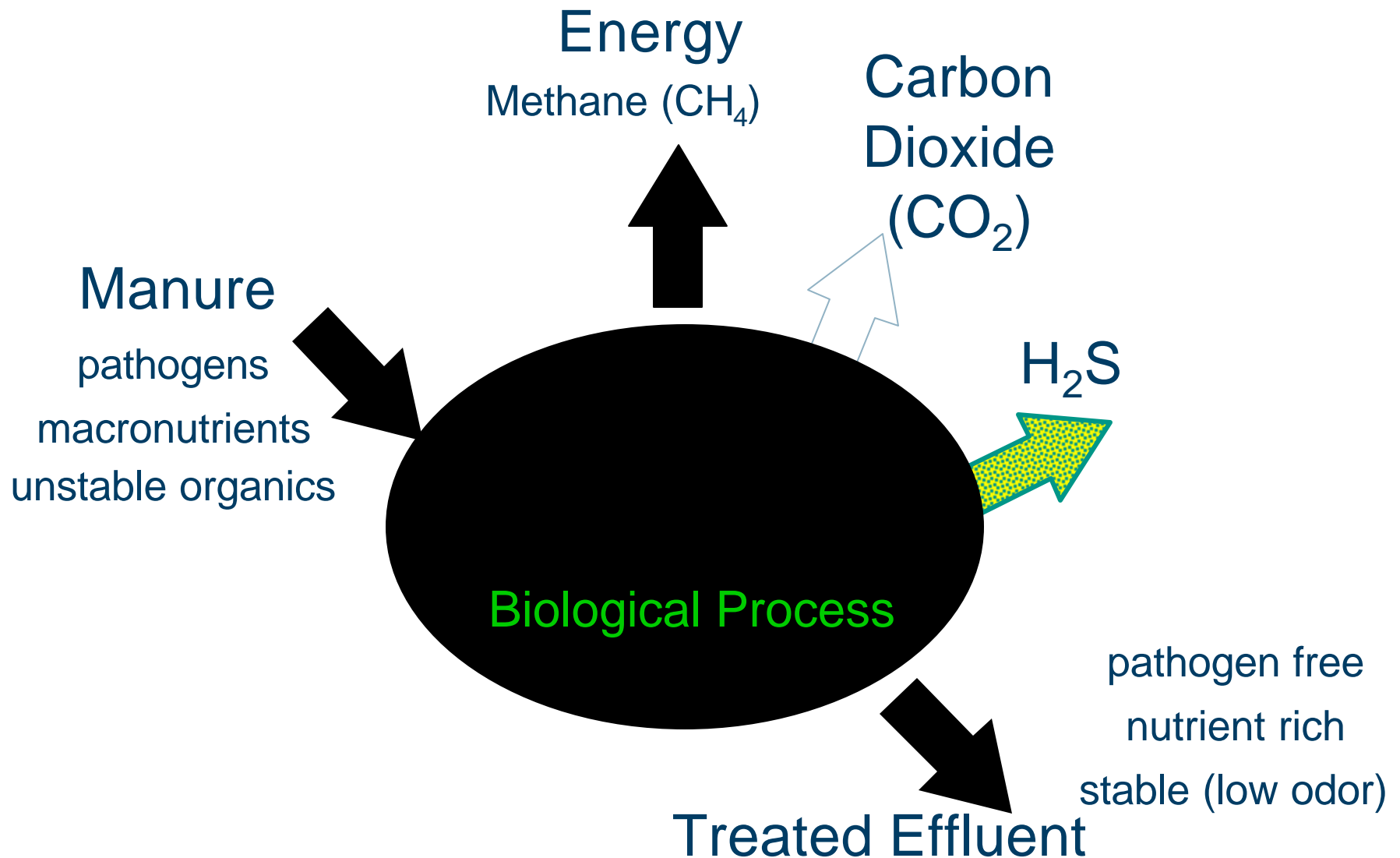
Waste Product



Biogas CHP Applications (Digester Gas)

- Animal Waste / Manure Management
- Food Processing Waste
- Waste Water Treatment Facilities

Anaerobic Digestion Process Overview



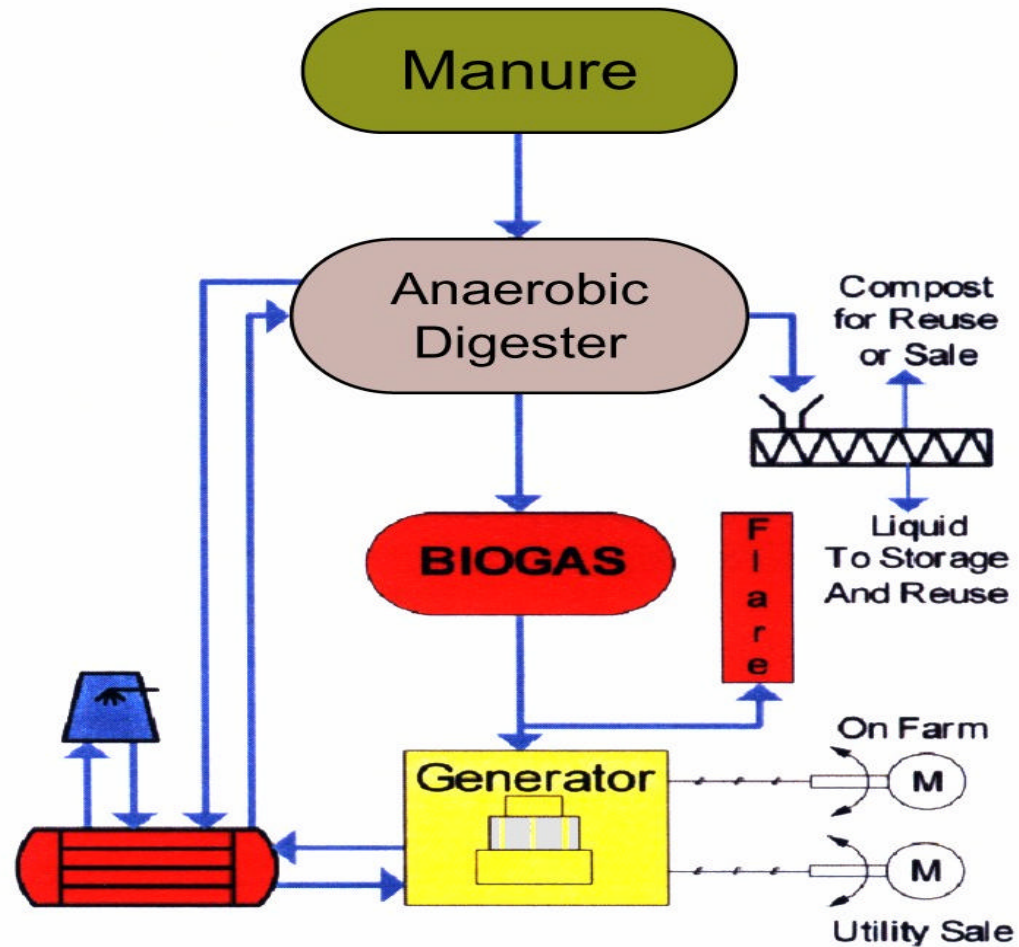
Energy Recovery – Biogas

(60% to 65% Methane)

- Flare It
- Use It for Heating
 - Displace Natural Gas / Propane
- Use It for CHP
 - Displace Purchased Electricity
 - Displace Natural Gas / Propane
- Clean It Up for Pipeline Use

Anaerobic Digester / CHP System

Manure Digestion



Advantages & Disadvantages CHP and Anaerobic Digesters

Advantages

- Odor & Insect Mitigation
- Nutrient Management
- Pathogen Reduction
- Energy Savings
- Heating Fuel Savings
- Reduced Electric Bills
- Qualified for Net Metering
- Potential Farm Bill Funding

Disadvantages

- Adding Complexity to Farming
- Commitment to Digester System Management (labor & maintenance)
- Commitment to CHP System Maintenance
- Capital Costs
- Electric Utility Interconnect can be Tedious

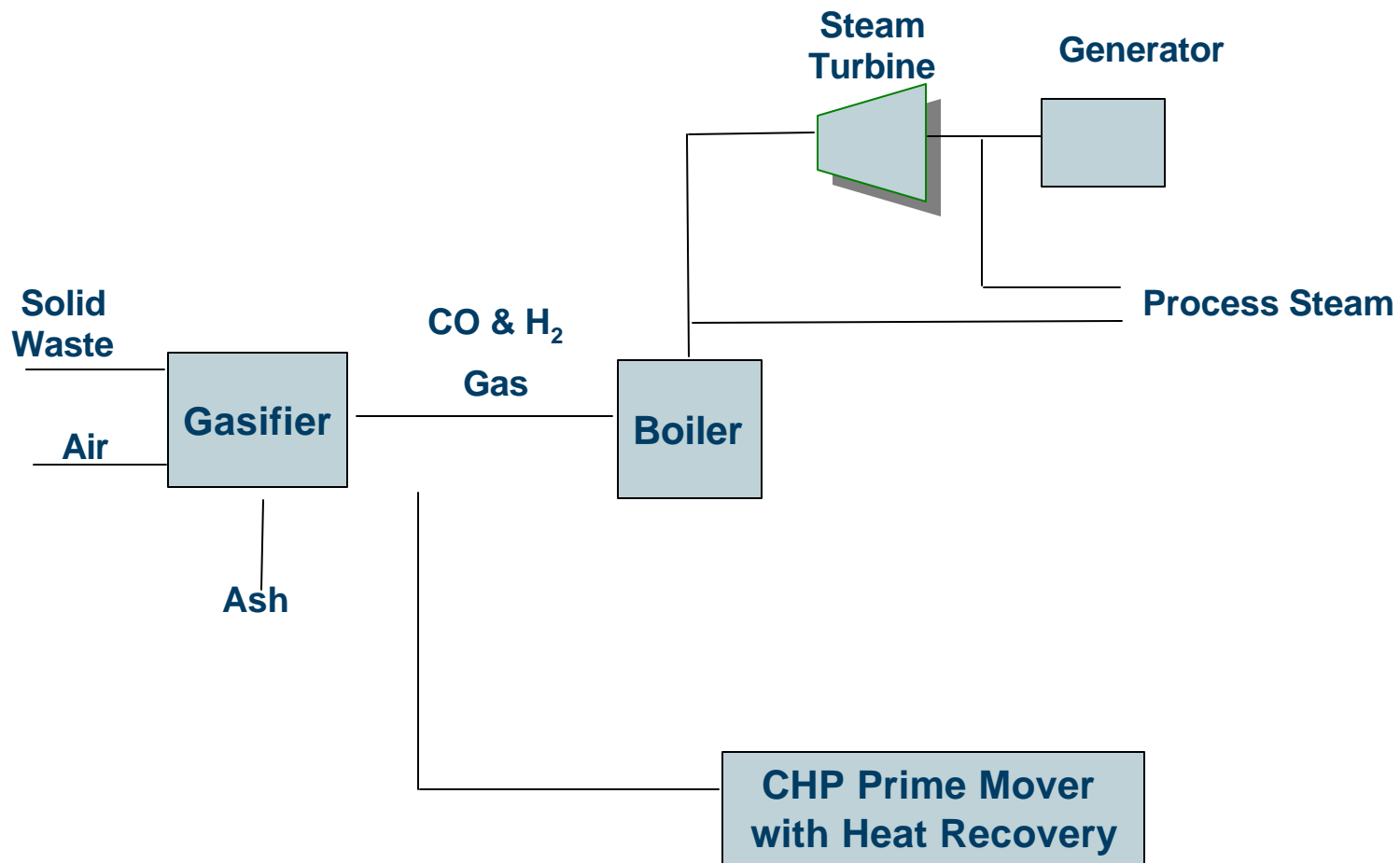
Expanded Applications

- Adding Food Processing Waste to a Manure System Can Increase Biogas Production with Higher Methane Content
- Community Digesters Provide Economic Development
- Tipping Fees Normal for Handling Food Wastes
- Bedding Material / Compost (potential revenues)

Gasification Process

- Pyrolysis: vaporize the volatile compounds & produce char (fixed carbon)
- Combust char with O_2 to form CO & CO_2 (generate the heat for gasification)
- Gasification: Char reacts with CO_2 & steam to produce CO & H_2
 - Producer Gas
 - Syn Gas
 - Wood Gas

Gasification – CHP System



Results – South Carolina Study

- Study: Availability of Poultry Manure in So Carolina & Assess Its Potential for Energy Generation
- Value as Fertilizer vs Feedstock for Energy Gen:
 - Fertilizer: Broilers \$38/ton ----- Turkeys \$52/ton
 - Anaerobic Digesters: \$30/ton
 - Gasifier: \$46 - \$50/ton
 - Combustion: \$53 - \$57/ton
- Estimated Electric Production Capability
 - 1000 tons/yr (on-site) ----- 50 to 70 kW
 - 10,000 tons/yr (off-site) ----- 500 to 700 kW
 - 50,000 tons/yr (county scale) ----- 2.5 to 3.5 MW

South Carolina Study (cont'd)

- Economic Analysis: (capital expenditures, O&M costs, litter cleanout & transportation, recoverable ash)
 - Small Scale (100kW) and Medium Scale (1MW) gasification is potentially more economically viable compared to anaerobic digestion and/or combustion

Reference: Availability of Poultry Manure As A Potential Bio-Fuel Feedstock for Energy Production – Flora & Riahi-Nezhad, Dep't of Civil/Environmental Engineering, Univ of South Carolina, August 2006

Summary

- Options Available for Animal and Wood Waste:
 - Anaerobic Digestion (biological)
 - Combustion (direct and/or co-firing)
 - Gasification (thermal)
- Swine & Dairy ---- more likely anaerobic digestion
- Poultry & Wood --- more likely gasification or combustion
- CHP should be seriously considered as an option
- Detailed economic site analysis needed

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Questions / Discussion

